APPENDIX H
PRELIMINARY DRAINAGE REPORT

PRELIMINARY DRAINAGE REPORT
NĀ PUA MAKANI WIND FARM

Kahuku, Oʻahu, Hawaiʻi
Tax Map Keys: 5-6-006:018,047,051,055; 5-6-005:018, 5-6-008:006

December 2014

Prepared for:
Champlin Hawaiʻi Wind Holdings LLC
2020 Alameda Padre Serra, Suite 123
Santa Barbara, CA 93102

Prepared by:
BELT COLLINS HAWAII LLC
2153 North King Street, Suite 200
Honolulu, Hawaiʻi 96819

2014.33.1001

1 PROJECT DESCRIPTION

1.1 GENERAL

The Nā Pua Makani Wind Farm project (Project) is located at the northeast coast of Oʻahu, in Kahuku and Kaʻena Town, Tax Map Key (TMK) 5-6-006:018,047,051,055; 5-6-005:018, 5-6-008:006. See Figure 1 – Location Map. The 707 acre project area is approximately 9,000 feet inland from the coast on a steep sloping ridge with elevations ranging from 13- to 400-feet above mean sea level.

Three alternatives evaluated in the Project EIS: Alternative 1 – No Action, Alternative 2 – Proposed Action Wind Project of up to 10 turbines (up to approximately 25 megawatts (MW)) and Alternative 3 – Larger Generation Wind Project of up to 12 turbines (up to 42-MW). Under Alternative 1, there will be no new construction of wind turbines, meteorological towers, supporting structures, and access roadways. Thus, the main focus of this report will only discuss Alternative 2 and 3.

Alternative 2 entails the construction and operation of an approximately 25 MW wind generation facility, consisting of 8 to 10 wind turbines, meteorological tower, operations and maintenance facility, electrical collections system, transmission line, and 16-foot- wide internal access roads using compacted gravel.

Alternative 3 entails the construction and operation of an approximately 42 MW wind generation facility, consisting of up to 12 wind turbines, meteorological tower, operations and maintenance facility, electrical collections system, transmission line, and 16-foot-wide access roads using compacted gravel.

1.2 EXISTING DRAINAGE

The developed portions of the project area consist mostly of agricultural and vegetated fields. Runoff generated onsite and offsite is routed through three gulches located in the project site. Farthest north of the project site is ʻŌhiʻaʻai Gulch, Keaʻaulu Gulch is located in the middle of the project site, and Lamaloa Gulch is to the south of the project site. Runoff from the three gulches discharges into Mālaekahana Stream or its tributaries just upstream of Kamehameha Highway which discharges directly to the Pacific Ocean.

2 REGULATORY REQUIREMENTS

2.1 CITY AND COUNTY OF HONOLULU (CCH) STORM DRAINAGE STANDARDS

The City and County of Honolulu Rules Relating to Storm Drainage Standards requires developments to manage storm water runoff such that there is no adverse impact to downstream properties, typically resulting from an increase in storm water runoff or a change in drainage patterns. On-site disposal or retention of the net increase in storm water runoff is proposed to mitigate any adverse downstream impact.

2.2 FLOOD HAZARD AREA

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM Panel 15003C0045G, effective date January 19, 2011), a portion of the project site is located within Zone AE, or areas where base flood elevations (BFEs) are determined; Zone A, or areas where no BFE is determined; Zone X, or areas determined to be outside of the 0.2% annual chance floodplain; and Zone D, or unstudied areas where flood hazards are undetermined but flooding is possible. See Figure 2 – Flood Zones. The AEF zone immediately adjacent to Kamehameha Highway is designated as a floodway.

Chapter 21-9.10-5 of the Revised Ordinances of Honolulu prohibits encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrological and hydraulic analyses that such encroachments would not result in any increased flood levels within the community during the occurrence of the base flood discharge.

3 ANALYSIS AND RESULTS

The approximate total area of proposed roadways, wind turbines, and structures is 8.9 acres and 10.4 acres for Alternative 2 and 3, respectively. The net change in runoff is computed using the rational method and the 10 year design storm. The on-site retention volume is computed using the modified rational method and the 50 year design storm. The design storm durations are equal to the time of concentration.

The runoff rate from the area to be occupied by the proposed improvements is computed for the existing and developed conditions and the net increase determined. Under the 10 year design storm, the net increase in storm water runoff is 7.1 cfs and 8.2 cfs for Alternative 2 and 3, respectively. See Appendix A for computations.

To mitigate any adverse downstream impact, the project will need to either dispose or store the net increase in runoff on-site. The criteria for disposal is a 10 year design storm and is limited to the installation of seepage pits or drywells. Additional subsurface investigation is needed to characterize the disposal rate of the project area. The alternative is to retain the runoff on-site using open detention areas or subsurface storage. The required storage volume, determined using the 50 year design storm, is 2.0 ac-ft and 2.4 ac-ft for Alternative 2 and 3, respectively, which may be provided in one or several distributed locations. The design of the on-site disposal or storage facilities would be developed in conjunction with preparation of detailed construction plans.

4 CONCLUSION

No adverse impacts to neighboring properties are expected. The net increase in runoff due to the proposed improvements will be mitigated through the use of on-site disposal and/or on-site detention. Drainage drywells or seepage pits may be used to dispose of the net increase in storm water runoff. Alternatively, the net increase in storm water runoff may be stored on-site using retention basins. The use of on-site disposal and retention, individually or in combination, will address the net increase in storm water runoff.

Improvements within the floodway are limited to surface pavements and underground power transmission lines. The conveyance capacity of the floodway is not expected to change as a result of these improvements, consequently, no rise in the BFE is expected.

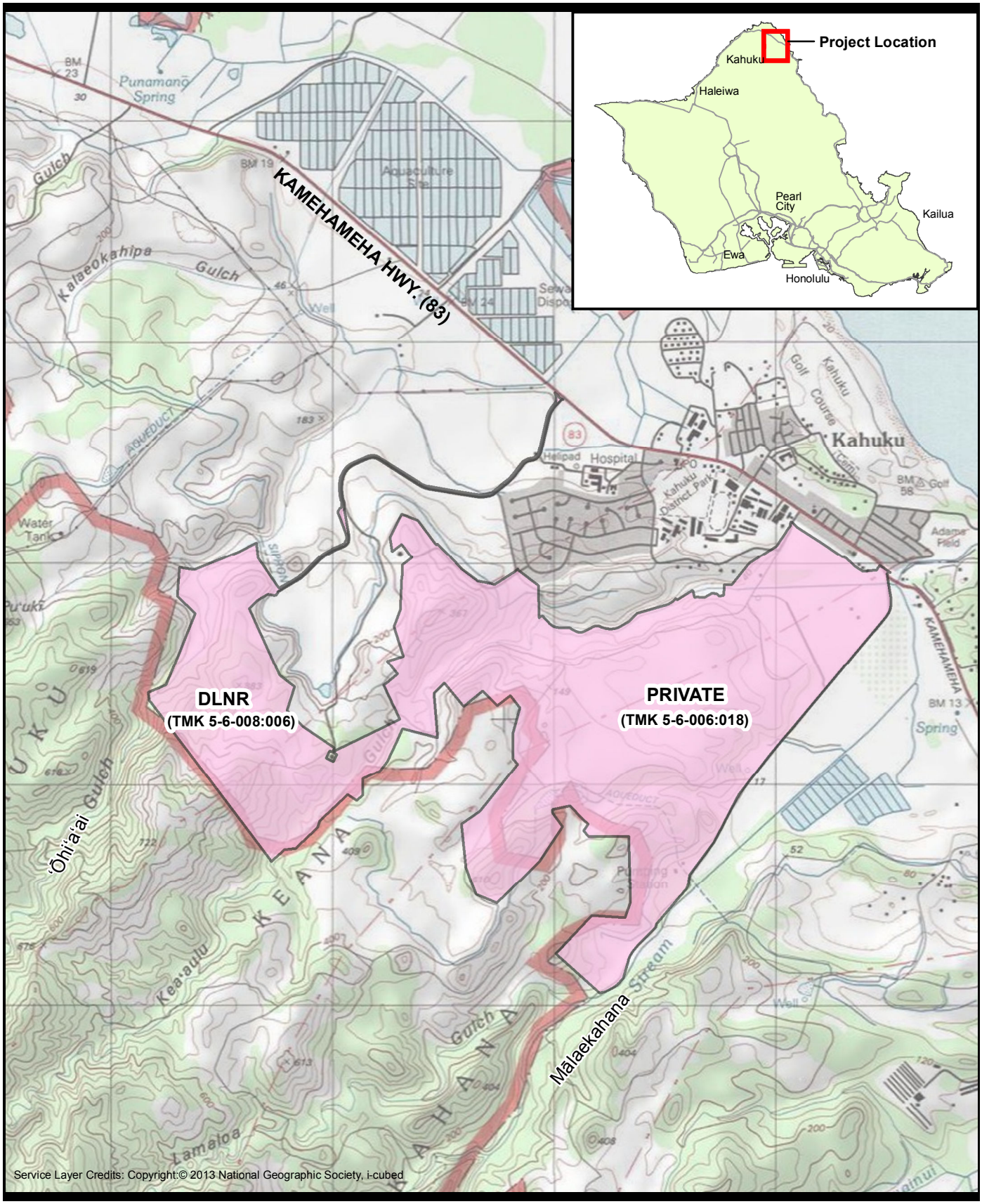
5 REFERENCES

- Flood Insurance Study, Volume 1 and 2, City and County of Honolulu, Hawai'i, Federal Emergency Management Agency, Revised November 26, 2010.

- Flood Insurance Rate Map, Map Number 15003C0045G, Federal Emergency Management Agency, Map Revised January 19, 2011.

- NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 4 Version 3: Hawaiian Islands, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Revised 2011.

Document Path: M:\Na Pua Makani Wind Farm\2014331001 Drainage Study\04 Graphics\GIS\Location Map_1.mxd



BELT COLLINS

NORTH

0 500 1,000 2,000

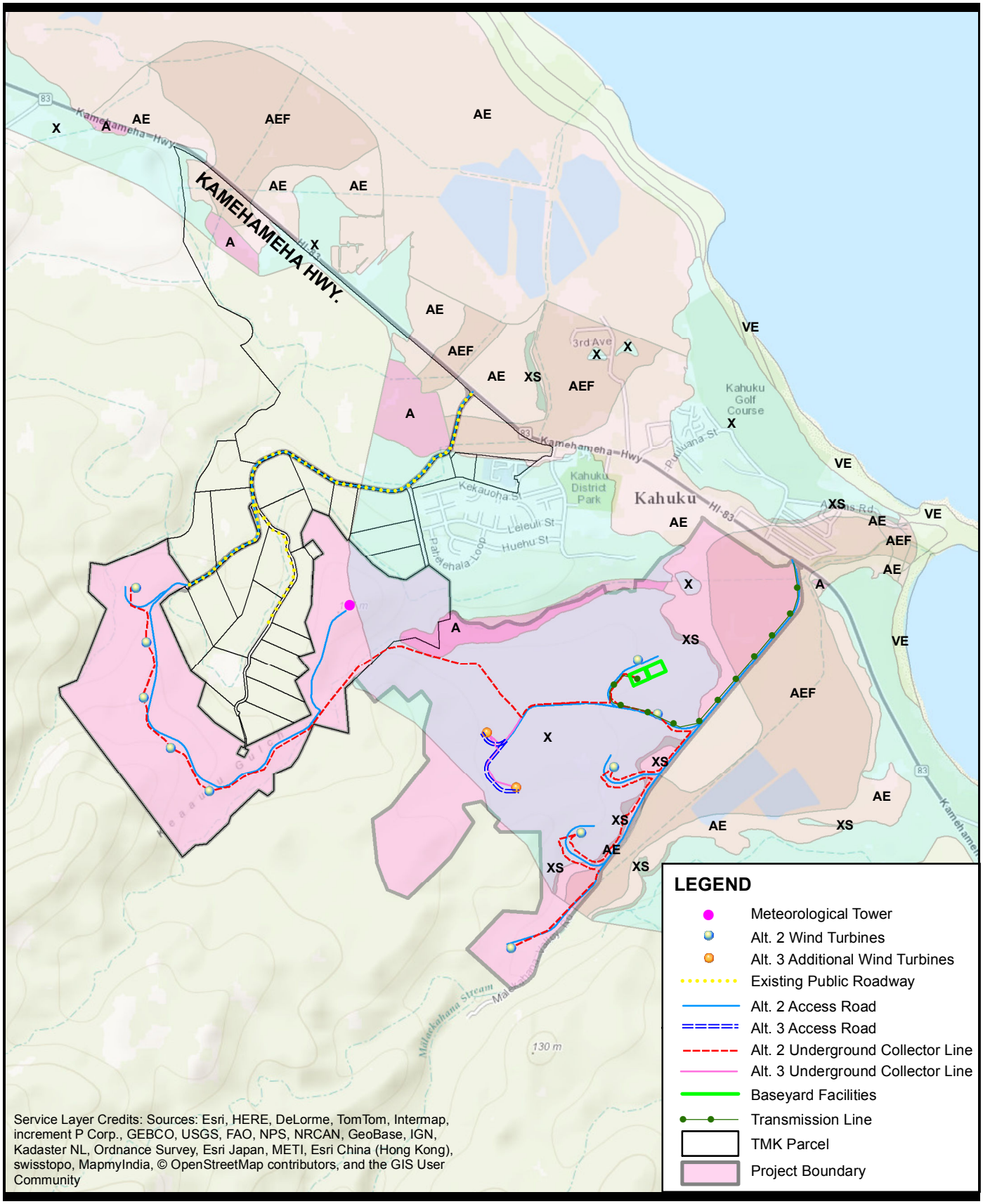
SCALE IN FEET

Figure 1

LOCATION MAP

Na Pua Makani Wind Farm
Champlin Hawaii Wind Holdings LLC
December 2014

Document Path: M:\Na Pua Makani Wind Farm\2014331001 Drainage Study\04 Graphics\GIS\2014331001_004 Flood Zones.mxd



BELT COLLINS

NORTH

0 500 1,000 2,000

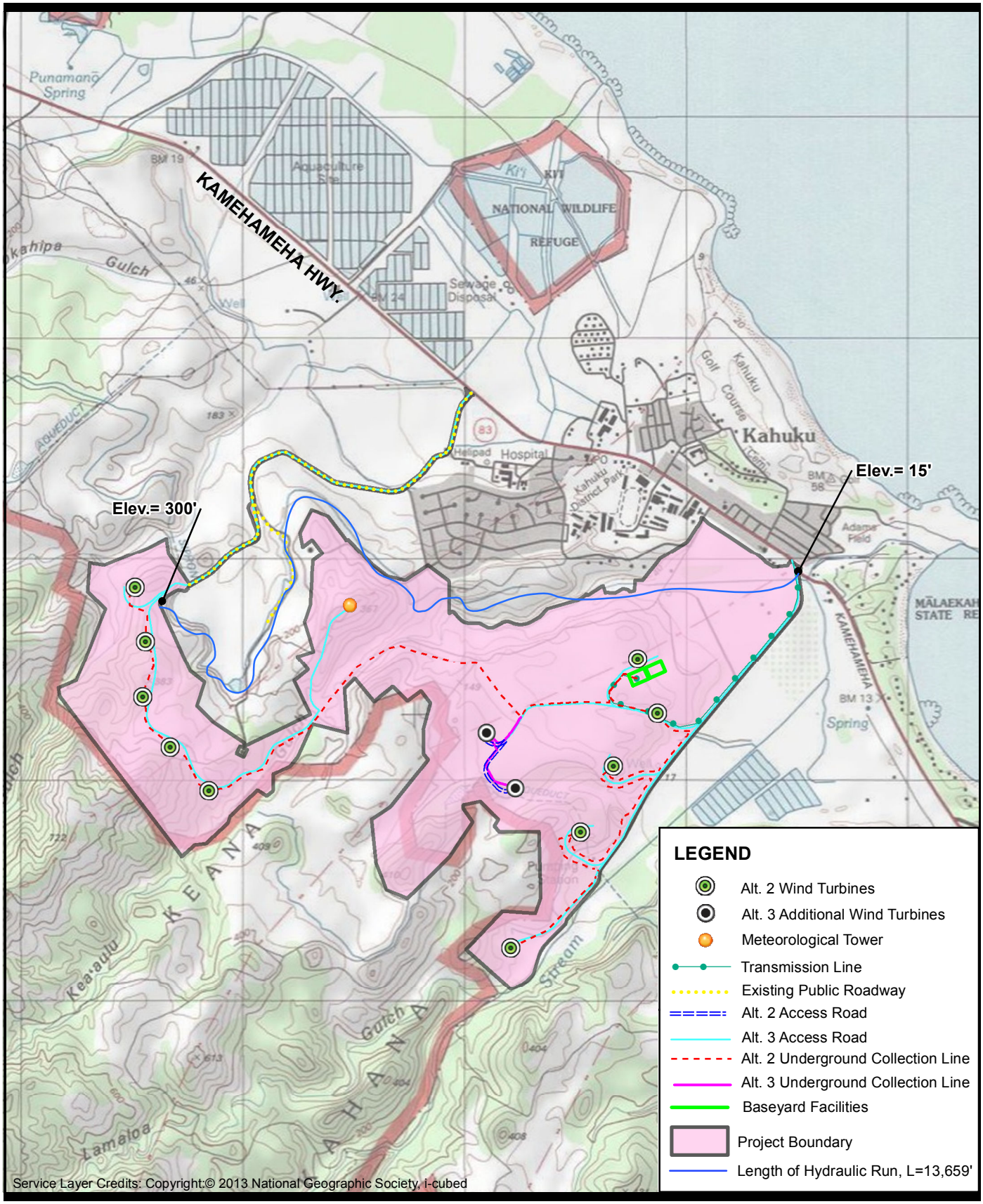
SCALE IN FEET

Figure 2

FLOOD ZONES

Nā Pua Makani Wind Farm
Champlin Hawaii Wind Holdings LLC
December 2014

Document Path: M:\Na Pua Makani Wind Farm\2014331001 Drainage Study\04 Graphics\GIS\2014331001_005 Time of Concentration.mxd



BELT COLLINS

NORTH

0 500 1,000 2,000

SCALE IN FEET

Figure 3

TIME OF CONCENTRATION

Nā Pua Makani Wind Farm
Champlin Hawaii Wind Holdings LLC
December 2014

PROJECT:	Nā Pua Makani Wind Farm	JOB NO:	2014.33.1001
CLIENT:	Champlin Hawai'i Wind Holdings LLC	DATE:	13-Nov-14
SUBJECT:	Preliminary Drainage Calculations Alternative 2	BY:	JC/CKL
FILE:	M:\Na Pua Makani Wind Farm\2014331001 Drainage Study\05 Basis of Design\Calculations\[Alternative 3 Runoff Calcs.xlsx]Runoff-Storage		

Runoff Coefficient, C

	Length (ft)	Width (ft)	Area (ac)	C Value	Composite C
Existing Condition					
Agriculture Areas	n/a	n/a	8.9	0.3	
Developed Condition					
Buildings and Yards	n/a	n/a	1.6	0.9	1.467
New gravel roads	19,700	16	7.2	0.70	5.1
			8.9		**0.74**

Time of Concentration, Tc

Length Hydraulic Run (ft)	13659
Start Elevation (ft)	300
End Elevation (ft)	15
Slope	2.1%
Open Channel Velocity (fps)	1.5
Tc (min)	151.8
Tc (hrs)	2.53

Runoff Rates

	Area (ac)	I_{10Y-2H} (in.)	I_{50Y-2H} (in.)	C	Q_{10} (cfs)	Q_{50} (cfs)
Existing Condition	8.9	1.82	2.53	0.30	4.84	6.73
Developed Condition	8.9	1.82	2.53	0.74	11.89	16.53
			Total Increase in Runoff (cfs) =		**7.05**	9.80

On-site Detention

Volume to store runoff (Q_{50} x Tc)	89,213	cf
Total on-site retention requirement =	**2.0**	ac-ft

PROJECT:	Nā Pua Makani Wind Farm	JOB NO:	2014.33.1001
CLIENT:	Champlin Hawai'i Wind Holdings LLC	DATE:	13-Nov-14
SUBJECT:	Preliminary Drainage Calculations Alternative 3	BY:	JC/CKL
FILE:	M:\Na Pua Makani Wind Farm\2014331001 Drainage Study\05 Basis of Design\Calculations\[Alternative 2 Runoff Calcs.xlsx]Runoff-Storage		

Runoff Coefficient, C

	Length (ft)	Width (ft)	Area (ac)	C Value	Composite C
Existing Condition					
Agriculture Areas	n/a	n/a	10.4	0.3	
Developed Condition					
Buildings and Yards	n/a	n/a	1.8	0.9	1.584
New gravel roads	23,400	16	8.6	0.70	6.0
			10.4		**0.73**

Time of Concentration, Tc

Length Hydraulic Run (ft)	13659
Start Elevation (ft)	300
End Elevation (ft)	15
Slope	2.1%
Open Channel Velocity (fps)	1.5
Tc (min)	151.8
Tc (hrs)	2.53

Runoff Rates

	Area (ac)	I_{10Y-2H} (in.)	I_{50Y-2H} (in.)	C	Q_{10} (cfs)	Q_{50} (cfs)
Existing Condition	10.4	1.82	2.53	0.30	5.65	7.86
Developed Condition	10.4	1.82	2.53	0.73	13.83	19.23
			Total Increase in Runoff (cfs) =		**8.2**	11.37

On-site Detention

Volume to store runoff (Q_{50} x Tc)	103,534	cf
Total on-site retention requirement =	**2.4**	ac-ft

NOAA Atlas 14, Volume 4, Version 3
Location name: Hauula, Hawaii, US*
Latitude: 21.6722°, Longitude: -157.9518°
Elevation: 118 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

S. Perica, D. Martin, B. Lin, T. Parzybok, D. Riley, M. Yekta, L. Hiner, L.-C. Chen, D. Brewer, F. Yan, K. Maitaria, C. Trypaluk, G. M. Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**4.44** (3.89-5.10)	**5.82** (5.02-6.78)	**7.62** (6.53-8.90)	**9.04** (7.66-10.6)	**11.0** (9.16-13.0)	**12.5** (10.3-15.0)	**14.0** (11.3-17.0)	**15.6** (12.3-19.1)	**17.8** (13.5-22.1)	**19.6** (14.4-24.6)
10-min	**3.29** (2.88-3.78)	**4.31** (3.72-5.02)	**5.65** (4.84-6.60)	**6.70** (5.68-7.87)	**8.14** (6.79-9.65)	**9.26** (7.61-11.1)	**10.4** (8.39-12.6)	**11.6** (9.13-14.2)	**13.2** (10.0-16.4)	**14.5** (10.6-18.3)
15-min	**2.76** (2.41-3.16)	**3.61** (3.11-4.20)	**4.73** (4.05-5.52)	**5.61** (4.75-6.58)	**6.82** (5.68-8.08)	**7.76** (6.37-9.28)	**8.72** (7.02-10.5)	**9.71** (7.64-11.9)	**11.1** (8.39-13.7)	**12.1** (8.90-15.3)
30-min	**1.94** (1.70-2.23)	**2.54** (2.19-2.96)	**3.33** (2.85-3.89)	**3.95** (3.34-4.63)	**4.80** (4.00-5.69)	**5.46** (4.48-6.53)	**6.13** (4.94-7.41)	**6.84** (5.38-8.34)	**7.79** (5.90-9.67)	**8.55** (6.27-10.8)
60-min	**1.28** (1.12-1.47)	**1.67** (1.44-1.95)	**2.19** (1.88-2.56)	**2.60** (2.20-3.05)	**3.15** (2.63-3.74)	**3.59** (2.95-4.30)	**4.04** (3.25-4.87)	**4.50** (3.54-5.49)	**5.12** (3.88-6.36)	**5.62** (4.12-7.08)
2-hr	**0.878** (0.755-1.00)	**1.16** (1.00-1.35)	**1.53** (1.31-1.79)	**1.82** (1.55-2.14)	**2.22** (1.85-2.63)	**2.53** (2.08-3.02)	**2.84** (2.29-3.43)	**3.17** (2.49-3.87)	**3.61** (2.74-4.48)	**3.96** (2.90-4.98)
3-hr	**0.663** (0.569-0.761)	**0.890** (0.768-1.03)	**1.18** (1.01-1.38)	**1.40** (1.20-1.65)	**1.71** (1.43-2.03)	**1.95** (1.61-2.33)	**2.20** (1.78-2.65)	**2.46** (1.94-2.99)	**2.80** (2.13-3.47)	**3.07** (2.26-3.86)
6-hr	**0.423** (0.361-0.487)	**0.562** (0.486-0.654)	**0.752** (0.645-0.879)	**0.900** (0.765-1.06)	**1.10** (0.923-1.31)	**1.26** (1.04-1.51)	**1.43** (1.15-1.72)	**1.59** (1.25-1.94)	**1.82** (1.38-2.26)	**2.00** (1.47-2.52)
12-hr	**0.255** (0.217-0.295)	**0.344** (0.297-0.399)	**0.467** (0.401-0.547)	**0.564** (0.480-0.664)	**0.697** (0.583-0.826)	**0.801** (0.658-0.957)	**0.906** (0.731-1.09)	**1.02** (0.800-1.24)	**1.17** (0.885-1.45)	**1.28** (0.941-1.62)
24-hr	**0.148** (0.125-0.175)	**0.206** (0.174-0.243)	**0.285** (0.240-0.337)	**0.347** (0.291-0.411)	**0.431** (0.360-0.514)	**0.498** (0.413-0.595)	**0.566** (0.467-0.680)	**0.637** (0.521-0.771)	**0.734** (0.592-0.896)	**0.810** (0.646-0.996)
2-day	**0.088** (0.076-0.102)	**0.121** (0.104-0.140)	**0.166** (0.142-0.192)	**0.200** (0.171-0.233)	**0.248** (0.211-0.290)	**0.285** (0.241-0.334)	**0.322** (0.270-0.381)	**0.361** (0.301-0.429)	**0.414** (0.341-0.496)	**0.456** (0.370-0.550)
3-day	**0.066** (0.056-0.076)	**0.089** (0.077-0.104)	**0.121** (0.104-0.141)	**0.146** (0.124-0.170)	**0.179** (0.152-0.210)	**0.204** (0.172-0.241)	**0.230** (0.193-0.272)	**0.257** (0.213-0.305)	**0.292** (0.239-0.351)	**0.319** (0.259-0.387)
4-day	**0.054** (0.047-0.064)	**0.074** (0.063-0.086)	**0.099** (0.084-0.116)	**0.118** (0.101-0.139)	**0.144** (0.122-0.170)	**0.164** (0.138-0.194)	**0.184** (0.154-0.218)	**0.204** (0.169-0.244)	**0.231** (0.189-0.278)	**0.251** (0.203-0.305)
7-day	**0.036** (0.031-0.042)	**0.048** (0.041-0.056)	**0.064** (0.055-0.075)	**0.076** (0.065-0.089)	**0.092** (0.078-0.108)	**0.104** (0.088-0.123)	**0.116** (0.097-0.138)	**0.128** (0.106-0.153)	**0.144** (0.118-0.173)	**0.155** (0.126-0.189)
10-day	**0.028** (0.024-0.033)	**0.038** (0.032-0.044)	**0.050** (0.043-0.058)	**0.059** (0.050-0.069)	**0.071** (0.060-0.083)	**0.080** (0.067-0.094)	**0.088** (0.074-0.105)	**0.097** (0.080-0.115)	**0.108** (0.089-0.130)	**0.116** (0.094-0.141)
20-day	**0.019** (0.016-0.022)	**0.025** (0.021-0.029)	**0.032** (0.028-0.038)	**0.038** (0.032-0.044)	**0.045** (0.038-0.053)	**0.050** (0.042-0.059)	**0.055** (0.046-0.065)	**0.059** (0.049-0.071)	**0.065** (0.054-0.079)	**0.070** (0.057-0.084)
30-day	**0.015** (0.013-0.017)	**0.019** (0.017-0.023)	**0.025** (0.022-0.029)	**0.029** (0.025-0.034)	**0.035** (0.029-0.041)	**0.038** (0.032-0.045)	**0.042** (0.035-0.050)	**0.046** (0.038-0.054)	**0.050** (0.041-0.060)	**0.053** (0.043-0.064)
45-day	**0.012** (0.010-0.014)	**0.015** (0.013-0.018)	**0.020** (0.017-0.023)	**0.023** (0.020-0.027)	**0.027** (0.023-0.032)	**0.030** (0.026-0.036)	**0.033** (0.028-0.039)	**0.036** (0.030-0.043)	**0.039** (0.032-0.047)	**0.042** (0.034-0.051)
60-day	**0.010** (0.009-0.012)	**0.013** (0.011-0.015)	**0.017** (0.014-0.020)	**0.020** (0.017-0.023)	**0.023** (0.019-0.027)	**0.025** (0.021-0.030)	**0.028** (0.023-0.033)	**0.030** (0.025-0.035)	**0.032** (0.027-0.039)	**0.034** (0.028-0.042)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical